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Medication Expenditure and Resource Utilization Among Patients with Musculoskeletal Disorders: Analysis of 2007 Medical Expenditure Panel Survey Data

Nipun Atreja

MEDICATION EXPENDITURE AND RESOURCE UTILIZATION AMONG PATIENTS WITH MUSCULOSKELETAL DISORDERS: ANALYSIS OF 2007 MEDICAL EXPENDITURE PANEL SURVEY DATA

A Thesis

Submitted to the Mylan School of Pharmacy

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In partial fulfillment of the requirements for

the degree of Master of Science

By

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ABSTRACT

MEDICATION EXPENDITURE AND RESOURCE UTILIZATION AMONG PATIENTS WITH MUSCULOSKELETAL DISORDERS: ANALYSIS OF 2007 MEDICAL EXPENDITURE PANEL SURVEY

By

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May 2012

Thesis Supervised by Dr. Khalid M. Kamal

Objective: To estimate the national prevalence and direct incremental expenditures of musculoskeletal disorders (MSD's) using the 2007 Medical Expenditure Panel Survey data.

Methods: A retrospective database analysis was conducted and individuals with MSD's (ICD-9-CM codes 274.00; 710.00-738.00) were identified. Dependent variables were total health care and other service category expenditures. The study utilized descriptive and regression analyses.

Results: In 2007, the national prevalence of MSD's was 33 million with incremental costs of $886.49 per person. The inpatient expenditures ($33,461.85) were the highest cost component in MSD's and the predictors of total health care expenditures were age, marital status, and presence of the disease condition.

Conclusion: The systematic assessment of MSD's and their associated incremental costs to the society is essential in increasing the awareness of decision makers to implement intervention strategies that are effective in lowering the disease incidence and in reducing the overall cost of disease management.

Keywords: Musculoskeletal disorders, Medical Expenditures Panel Survey, incremental health care expenditures, retrospective analysis, MSD's, MEPS.

DEDICATION

TO MY FAMILY

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CHAPTER ONE

INTRODUCTION

According to the Federal Bureau of Labor Statistics (BLS), musculoskeletal disorders (MSD's) include injuries and disorders to muscles, nerves, tendons, ligaments, joints, cartilage, and spinal discs.[1] MSD's do not include injuries resulting from slips, trips, falls, or similar accidents. The term MSD's identifies a large group of conditions that result from body trauma and often involves the joint, muscle and bone. The major disorders included under MSD's are diffuse diseases of connective tissue, arthropathies, rheumatoid arthritis (RA), osteoarthritis (OA), ankylosing spondylitis (AS), spondylosis, polymyalgia rheumatica, disorders of soft tissues, osteomyelitis periostitis, disorders of bone and cartilage, and other acquired musculoskeletal deformities.

Epidemiology

The World Health Organization (WHO) scientific group have projected an increase in the burden of MSD's in the developed and developing countries primarily due to an increase in the overall life expectancy of the population and the subsequent increase in non-communicable diseases.[2] According to the Bone and Joint Organization estimates, by 2030, individuals aged 65 years and older will double in size and the fastest growth will be seen in individuals over 85 years of age.[3] This in turn would potentially result in increased cases of MSD's in the society.

The prevalence of MSD's in the United States (US) ranged from 27.8% – 30.2% between 1997 and 2000.[4] The incidence of MSDs increased by 16% between 1996-1998 and 2002-2004 and in 2008, an estimated 110 million adults (approximately 50% of the adult population) reported having a disabling musculoskeletal condition. Currently, one in four individuals has a MSD that requires medical attention. [4]

MSD's are the leading occupational disease among all work-related illnesses not only in the US but also in Nordic countries and Japan.[3] An estimated 40% of all upper extremity disorders in the employed population of the US are due to occupational exposure and the prevalence of MSD's is higher in labor intensive production units such as furniture and heavy machinery.[5]

Economic and Humanistic Burden of MSD's

MSD's have substantial economic and humanistic impact on the US health care system. The annual direct and indirect costs for the treatment of MSD's is approximately $849 billion, which is around 7.7% of the US Gross Domestic Product (GDP).[3] Over the last decade, there has been two percentage points increase in the population that needs medical care for problems related to MSD's. This has resulted in a 41% increase in direct medical costs associated with MSD's. [6]

The direct cost of treatment of MSD's in 2002-04 was $510 billion (~ 4.6% of US GDP).[6] Almost 85% of the people affected by the MSD's reported at least one ambulatory visit to physician's office. In 2002-2004, ambulatory physician visits due to

MSD's were 507.9 million (52%) compared to 425.5 million (40%) in1996-1998.[6] Due to an increase in the number of MSD's-related visits over the same period, a 69% increase in the total non-physician ambulatory visits at a cost of $135.3 million was incurred.[6] Prescription drug utilization is also significant in this population. The mean prescriptions filled per person increased from 13.1 in 1996-1998 to 18.6 in 2002-2004 resulting in a financial burden of $1.6 billion in 2002-2004.[6]

The indirect costs of MSD's in the age group of 18-64 years were $339 billion (~ 3.1% of the US GDP). Some of the major factors that contribute to these costs include loss in wages due to presenteeism (not functioning to 100% of the work ability), and absenteeism (absent from work due to an illness).[6] Additionally, individuals with MSD's have reportedly decreased the numbers of hours they work, some have changed jobs that require less physical activity, while others have completely left working, thereby adding to the loss in productivity.[7]

In addition to the economic impact, MSD's have a tremendous effect on individual's quality of life (QoL).[3] Compared to gastrointestinal conditions, chronic respiratory diseases, and cardiovascular conditions, individuals with MSD's report poorer QoL, especially for bodily pain and physical function.[8] Musculoskeletal disorders are also a major cause of pain in the elderly population and are responsible for functional impairment which restricts mobility and self-care tasks.[9] MSD's are one of the most common cause of disability in the US. MSD's cause many long-term physical disabilities whose impact sometimes leads to major changes in the life of the people suffering from these disorders. The impact of MSD's on the health-related quality of life (HRQoL) of

individuals due to its impact on pain and reduced physical function is also well documented.[9]

Pathology, Epidemiology and Management of Major Disorders under MSD's

Gout

Gout is a heterogeneous disease characterized by deposition of monosodium urate crystals in the joints and surrounding tissues resulting in severe pain and erythema.[10] Depending on the severity of the disorder, gout can be classified into acute and chronic gout. The symptomatic classification of gout is as follows[11]: asymptomatic hyperuricemia, acute gouty arthritis, intercritical gout, and chronic tophaceous gout.

The prevalence of gout in the US is higher than many countries and the rates range from 0.47% to 0.52%.[11] Elderly individuals, those with transplantation (allograft) and renal insufficiency are at an increased risk of developing gout.[12] The most common risk factor associated with gout includes hyperuricemia which is generally triggered by the consumption of alcohol and diet rich in purine, drugs such as thiazide diuretics, loop diuretics, and cyclosporine also play a role in potentiating the development of hyperuricemia.[12]

The monitoring of renal uric acid excretion is important for the systematic management of gout. However, the presence of co-morbidities, especially in the acute stages of gout complicates the disease management. The following drugs are commonly

used in the treatment of gout: colchicine, NSAIDs (Ketoprofin and Ibuprofen), corticosteroids, anakinra, uric acid lowering drugs (allopurinol, xanthine oxidase inhibitor), febuxostat (novel drug with more potency), probencid, and pegylated uricase.[10]

Ankylosing Spondylitis

Ankylosing Spondylitis (AS) is a chronic disabling arthritic condition characterized by severe inflammatory chronic back pain.[13] The occurrence of AS is strongly associated with the expression of HLA B27genotype and is also triggered by microbial infections. As the disease progresses, the joint pain worsens, and the inflammation spreads to eyes, hips, knees, lungs, entire spinal assembly, shoulders, tendons and various ligaments attached to bones.[14] The incidence of AS is estimated at 0.8 % in adults aged 25 to 49 years.[14] Males are more susceptible to AS compared to females and this disorder also affects young adults between the ages of 20 and 30 years.[14]

The goal of AS management is to reduce the intensity of inflammation, pain and stiffness due to the disease.[14] The commonly used drugs are NSAIDS, analgesics (paracetamol and opioid drugs), disease modifying anti-rheumatic drugs (methotrexate and sulfasalazine)[15] and tumor-necrosis-factor alpha (TNF-α) blockers (etanercept, infliximab, adalimubab, and golimubab).[16]

Osteoarthritis

Osteoarthritis (OA) is a degenerative joint disorder that mainly affects the cartilage cells. It is considered an acquired degenerative process due to its genetic predisposition. Around, 70- 90% of the geriatric population (75 years and above) have at least one joint affected with OA and this condition is considered as the second most common form of disability among women and men. This condition can be managed and treated by family physicians but in severe cases, surgery is recommended. The OA of knee and hip are very common with a prevalence of 6% and 3%, respectively in US adults.[17]

A variety of factors such as heredity, age, deposition of urate crystals in the joints, occupational markers, high bone mineral density, peripheral neuropathy, obesity and trauma are probable risk factors of OA. Some factors such as severe athletic exercises and sports involving torsional impact are also considered as probable risk factors of OA.[18]

The management of OA includes pharmacotherapy, physiotherapy, novel genetic engineering techniques and also patient education. The medications that are recommended to relieve the pain are NSAIDs and analgesics. The alternative medicine for OA includes glucosamine sulfate and chondroitin sulfate although their clinical effectiveness is yet to be proven.[19]

Rheumatoid Arthritis

Rheumatoid Arthritis (RA) is a chronic, inflammatory, autoimmune disorder which is characterized by severe inflammation in the joints along with swelling, stiffness, damage of the cartilage and bone around the infected joint. There is no complete cure for this disease, however, there are a number of disease modifying anti-rheumatic drugs, NSAIDS, analgesics, steroids, physical exercises and patient education that are recommended in the management of RA.[20] RA results in permanent damage to the affected part or deformity or immobilization accompanied by symptoms like low grade fever, fatigue, anemia, pericarditis, myocarditis or pulmonary fibrosis. This disorder affects the individual's life style and severely compromises their QoL.[21] RA affects around 1.3 million people in the US with an increase in the disease incidence seen in women over the last decade.[21]

Problem Statement

MSD's are a major cause of morbidity and health care burden in the US and their impact on clinicians, payers, patients, and the society as a whole is pervasive. In the US, MSD's were reported by 107 million adults in 2005 and were the leading cause of disability accounting for more than one-half of all chronic conditions in individuals over 50 years of age. Given the high prevalence rates, these conditions have been consistently included as leading health indicators in both Healthy People 2010 and 2020.[22] The prevalence of MSD's have been shown to increase markedly with age, and are affected by

lifestyle factors, such as obesity and lack of physical activity. With a projected increase in the aging population over the next two decades, coupled with an increasing sedentary lifestyle, there is a strong possibility for a dramatic increase in the burden of MSD's on the society.[23] The burden of MSD's in terms of resource utilization and costs to the society would thus be staggering. Current estimates show that MSD's present a multi-billion-dollar-a-year burden on the society.[23] The per capita medical care expenditures of persons with musculoskeletal conditions in 1996 averaged $3,578, amounting to a national total expense of $193 billion (~2.5% of US GDP).[24] By 2006, the medical expenditures for MSD's had increased to $950 billion (7.4% of GDP) and this is further expected to increase given the expected growth in the aging population.[6]

In MSD's, the major direct cost components include hospitalizations, ambulatory care, and prescription drugs. People with MSD's have 50% higher health care expenditures compared to non-MSD's ($3,578 against $ 2,313). Out of the total health care cost, hospitalization costs accounts for 37% of the cost .[25] Additionally, indirect costs, primarily in the form of lost wages associated with MSD's, contribute substantially to the health care burden with an estimated cost of $373.1 billion in 2006 (~2.9% of US GDP).[6]

Prescription drug cost is another major component of the overall direct medical cost, along with the physician and other service provider costs in MSD's. In the last decade, there has been a paradigm shift in the treatment of MSD's, especially with the introduction of biologic therapies in RA and AS. Biologics are reported to have excellent therapeutic efficacy, however, the treatment cost has increased significantly as these

classes of drugs are very expensive.[26] Previous estimates of the burden of MSDs on the society have not included the cost impact of these biologics on the total health care costs. Thus, there is a gap in the literature on the new treatment cost estimates and the type of health care resources that are utilized in MSD's. Moreover, it is important to assess the cost of treatment of MSD's, especially under different service categories like inpatient, outpatient, and prescription drug services. It would also be of great interest to different decision makers such as payers and clinicians to know the incremental costs of MSD's compared to the other disease conditions. Incremental cost calculations can help understand the contribution of different service categories to the overall costs and therefore, facilitate decisions pertaining to efficient resource allocation.

The costs assessment needs to focus on important demographic factors such as gender, race, age, and geographic region to better understand the disparity in terms of prevalence and national estimates among individuals with MSD's. Specifically, studies have shown that women and elderly are majorly affected by MSD's. Thus, assessing the treatment cost of MSD's based on demographic profiles would further help in determining the predictors of resource utilization and identifying US regions where there is a high prevalence and resource utilization. The study estimates can serve as a guide for policy makers in the formulation of health care policies on screening, treatment guidelines, and identification of high-risk population for MSD's.

Conceptual Framework

The objective of this study is to develop a national assessment of the incremental resource utilization in individuals with MSD's compared to those without MSD's, using a retrospective analysis of 2007 Medical Expenditure Panel Survey (MEPS) data. Incremental cost analysis is a decision-making technique used to determine the true cost difference between alternatives. In addition to calculating the incremental costs, the study has two more objectives. First, to focus on the different health care service categories that contribute to the overall health care expenditures in individuals with MSD's and non-MSD's and second, to evaluate the disparity in demographic variables such as age, gender, race, and geographic location on different health care service categories.

The study will use 2007 MEPS data for all the analysis. MEPS is a third in the series of nationally representative surveys of medical care use and expenditure sponsored by the Agency for the Health Care Policy and Research (AHCPR).[27] MEPS database provides national information on the types of health services used in the US, and how frequently the health services are used.

MEPS database comprises of three components. These include:

1) *Household component (HC)*: Provides detailed information on the demographic characteristics, health status, health insurance, employment, and medical care use and expenses of the individuals.

2) *Medical Provider Component (MPC)*: Provides additional information on specific International Classification of Diseases - 9 (ICD-9) codes, Current Procedural Terminology (CPT) codes and Diagnosis-Related Group (DRG) codes used by the physicians and hospitals.

3) *Insurance Component (IC)*: Provides data on the number and types of private health insurance plans offered, benefits associated with these plans, premiums, contributions by employers and employees, eligibility requirements, and employer characteristics.

The study will use the HC and MPC of the 2007 MEPS database. The study will identify the individuals diagnosed with MSD's and those without MSD's, and categorize them into two cohorts based on the ICD-9 codes. Overall disease burden, incremental costs, health care expenditures including different service categories and demographic disparities in health care expenditures will be estimated in the two cohorts.

Hypothesis

The overall hypothesis is that resource utilization in individuals with MSD's will be higher than the non-MSD cohort.

Study Objectives

The specific study objectives include:

Objective 1: To identify the characteristics of the total population surveyed in 2007

MEPS data.

Objective 2: To identify the demographic characteristics of individuals diagnosed with MSD's and non-MSD in 2007 MEPS data.

Objective 3: To estimate the mean expenditures for total health care expenditures, total office-based expenditures, total outpatient expenditures, total inpatient expenditures, total emergency room expenditures, total office-based chiropractor expenditures, and total prescription expenditures in individuals with MSD's and non-MSD.

Objective 4: To identify the predictors for total health expenditures, total office-based expenditures, total outpatient expenditures, total inpatient expenditures, total emergency room expenditures, total office-based chiropractor expenditures, and total prescription expenditures in individuals with MSD's and non-MSD.

Objective 5: To calculate a national estimate for the total incremental health care expenditures of MSD's compared to non-MSD.

Significance of the Study

The overall goal of the study is to provide prevalence and cost estimates for MSD's using 2007 MEPS data. The study aims at updating old cost estimates from the 1990s since there has been a significant change in the management of MSD's. This study can be instrumental in public health policy debates as it highlights the magnitude of the impact of MSD's on our society. The calculation of the cost estimates for different

service categories are useful in understanding the value of new technologies that are introduced in the market. Once the true cost impact of the disease is known, policy makers can then estimate the resources that could potentially be saved or gained if the disease is managed at an early stage. It would also be useful to understand the possible cost offsets that can accrue due to the implementation of preventive programs such as screenings or testing. Based on past research, preventive programs have been shown to be cost effective and result in efficient use of existing health care technology. Thus, the overall costs assessment can help policy makers decide the right course of action in terms of resource allocations and prevention policies.

Understanding the socio-demographic characteristics of individuals with MSD's will aid in indentifying the population at-risk by studying the predictors and by further studying the sub-categories which are significant for the specific health care service categories. Based on the study results, emphasis can be placed on interventional strategies that can target these populations with a goal of reducing the disease prevalence. These interventions are also helpful in improving the QoL of the individuals and the significant resource utilization associated with MSD's. Evidence from similar intervention strategies for diabetes and hypertension have shown that these strategies are very effective in lowering the disease incidence and reducing cost of disease management.[28] This study includes a number of MSD's such as invertible disc disorder, curvature of spine that are less prevalent in the population but incur significant resource utilizations. In the past, studies have mainly focused on major MSD conditions such as RA, OA, AS, and gout.

The study results can be used by different stake holders in developing new and improved disease management strategies. From a clinician's perspective, this study will provide them with information about the target population and the need for adhering to appropriate treatment guidelines. This study will help managed care organizations to better understand the cost burden of MSD's and assist them in structuring effective guidelines to provide low cost and better care to individuals with MSD's. The study will further provide significant information to the policy makers for setting priorities in resource allocation, taking into account the huge economic impact of these conditions.

The next chapter will discuss the prevalence and costs studies that have been conducted in MSD's.

CHAPTER TWO

LITERATURE REVIEW

This chapter provides an in-depth review of the literature for the following: (i) MSD's-related prevalence, (ii) Burden of MSD's on the US health care system.

Search Strategy

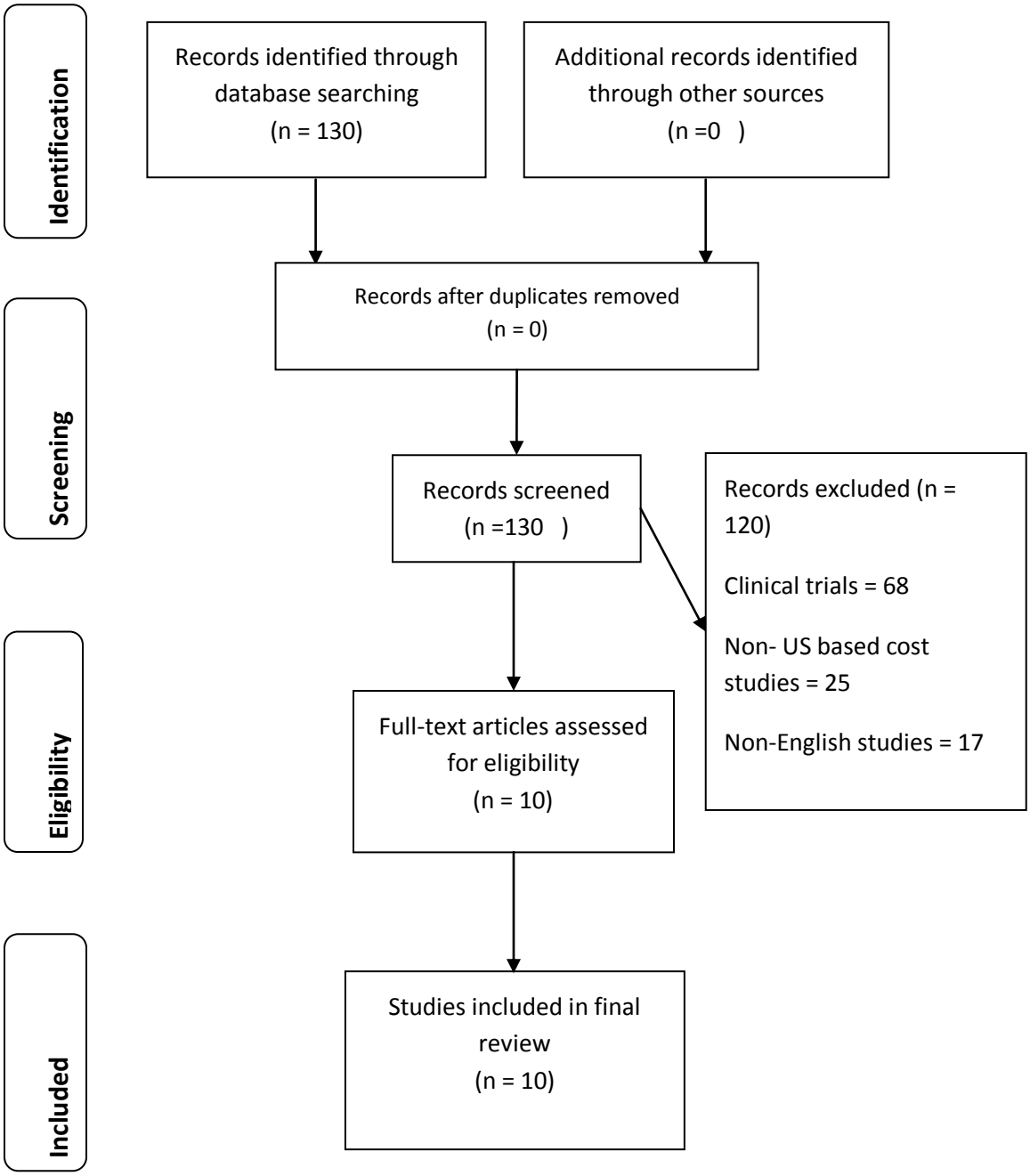
Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines**,** a systematic literature search was conducted among peer-reviewed journals from January 1990 to January 2012 in electronic databases such as Pubmed (Figure 1).[29] The search was limited to studies in English language.

The search strategy included the following search terms or their combinations: musculoskeletal disorders, rheumatic condition, rheumatoid arthritis, osteoarthritis, joint pain, cost, disease burden, prevalence, epidemiology, predictors, biologics, service categories, inpatient, outpatient, prescription drugs, and emergency room.

Inclusion/Exclusion Criteria

Articles were included in the final review if they estimated the prevalence of MSD's or if they assessed the cost impact of MSD's. Randomized clinical trials, drug-specific cost studies, pharmacoeconomic studies for MSD's treatments, costs studies conducted outside of the US, and review articles were excluded from the review.

Figure 1.PRISMA diagram elaborates the step wise selection of studies for the literature search.



The 10 articles included in the review were categorized as follows:

- Prevalence of MSD's.
- Burden of MSD's on the US health care system.

Prevalence of MSD's

There are only four studies that have estimated the prevalence of MSD's in the US population. The Bone and Joint Organization used the 2008 National Health Interview Survey (NHIS) to estimate the prevalence of MSD's and reported approximately, 110.34 million adults with a musculoskeletal condition.[6] Jacobs and colleagues (2008) reported a total of 107.7 million adults suffering from musculoskeletal conditions with one in two adults suffering from MSD's in 2005.[30] Older estimates indicate that the prevalence of MSD's in the US has increased at an alarming rate. Yelin and colleagues (2001) reported a prevalence rate of 53.93 million adults, which was approximately 20.1% of the US population in 1996.[24] Another study by Lawrence and colleagues (1998) used the 1990 National Health and Nutrition Examination Survey (NHANES) data to estimate the prevalence of MSD's and then extrapolated the results to the year 2020. Approximately, 37.9 million (15%) individuals in 1990 had some form of arthritis or rheumatic condition and MSD cases were predicted to increase to 59.4 million (18.2%) by 2020.[31]

Yelin and colleagues (2007) expanded the definition of MSD's to include other rheumatic conditions such as rheumatic fever, other peripheral vascular disease, and polyarteritis nodosa and allied conditions and labeled the group as arthritis and other

rheumatic conditions (AORC). The authors estimated the prevalence of AORC between 1997 and 2003 using MEPS database. The prevalence of AORC in 1997 was 36.799 million adults (18.7% of the US population), and increased to 46.114 million in 2003 (21.5% of the US population).[32] Some prevalence data have also been reported for specific MSD conditions such as RA, OA, AS, and gout. Simon and colleagues (2012) reported the prevalence rates of RA over three consecutive years: 0.40% in 2004, 0.44% in 2005, and 0.43% in 2006. Helmick and colleagues (2008) used 2005 National Health Interview Survey (NHIS) data to estimate the prevalence of OA, AS, and gout. Nearly 27 million adults had clinically proven osteoarthritis (up from 21 million in 1995). The prevalence rate of AS was 30 - 900 per 100,000 and gout was self-reported by 3 million adults (up from 2.1 million in 1995).[33]

Prevalence estimates from the literature suggests that the rate has nearly doubled in the last two decades. The prevalence of MSD's in the US shows a rising trajectory especially due to the dramatic growth in numbers and proportions of the elderly coupled with increased life expectancies.

Burden of MSD's on the US Health Care System

Three studies have reported economic burden of MSD's on the US health care system. Jacobs (2008) estimated the total cost for MSD's treatments at $849 billion with $510 billion in direct costs and $339 billion in indirect costs. Just like the prevalence data, older estimates are considerably lower than the newer estimates.[30] Yelin and colleagues (2001) utilized the 1996 MEPS data to estimate the national expense and individual's annual average medical care expense for MSD's. The national expense for

MSD's was estimated at $193 billion with an individual's annual average expense at $3,578.[24] In another study, Yelin and colleagues (2004) expanded the definition of MSD's by including rheumatic conditions and used this group to estimate the earning losses of individuals with AORC. Estimates from the 1997 MEPS data indicated a total of 38.4 million individuals with AORC, with an individual's mean total medical expenditure at $4,865 and a national annual burden of $186.9 billion.[32]

Yelin and colleagues conducted two studies that estimated the predictors of resource utilization. The first study utilized the 1996 MEPS data to study the predictors of MSD's while the second study utilized the 2003 MEPS data to study the predictors AORC. For both MSD's and AORC, inpatient cost was the biggest contributor to the total resource utilization. In MSD's, inpatient cost was 37% of the total cost compared to 32% for AORC. After inpatient costs, outpatient costs were the next category that contributed most to the resource utilization. For MSD's, the outpatient costs contributed 23% to the total cost while for AORC, it was 32%. Since the additional conditions included under AORC compared to MSD's require more outpatient treatment, there is a trend for more expenditure on an outpatient basis for AORC compared to MSD's. Similarly, MSD's require more hospitalizations and therefore, the trend for MSD's was higher expenditures in inpatient setting compared to AORC. Prescription drug costs were also a major contributor to the overall cost for MSD's (16%) and AORC (23%).[24, 32]

Predictors of resource utilization for specific musculoskeletal conditions have also been reported in the literature. Lurie and colleagues (2008) estimated the out-of-pocket costs in individuals with RA from 1998 to 2004 using MEPS data. The total out-of-pocket expenditures among individuals with RA increased by 52.5%, primarily due to a

72% increase in the median out-of-pocket expenditures for RA prescription drugs from 1998 to 2004.[34] Gabriel and colleagues (1997) estimated the direct medical costs associated with OA and RA and compared the costs to a control group which included individuals without arthritis. The use of prescription medications was higher for RA (96.3%) and OA (96%) compared to the control group (83%).[35]

Studies have calculated the incremental costs of MSD's compared non-MSD. Individuals with MSD's had 50% higher care expenditures ($3,578) compared to the non-MSD's cohort ($2,313) with a national incremental cost of $193 billion. Another study calculated the mean incremental medical care expenditures attributable to AORC reported an incremental cost of $1,752, with a national burden of $80.8 billion.[24, 32]

This review highlights the paucity of recent estimates of MSD's prevalence rates, total economic burden, and the predictors of resource utilization. The goal of the current study is to provide newer estimates based on the 2007 MEPS data.

CHAPTER THREE

METHODOLOGY

This chapter describes data source, data extraction, independent and dependent variables, and the statistical analyses used in the study.

Data Source

The study utilized 2007 Medical Expenditure Panel Survey (MEPS) data for all the analyses. The MEPS data is sponsored by the Agency for Health Care Policy and Research (AHCPR) and is administered annually since 1996. The MEPS data measures the frequency of the health care services utilized by US civilian non-institutionalized population and provides national estimates of the medical use and total expenditures of health care resources. In addition to the treatment cost, the database also provides demographics (e.g., age, gender, and race), and insurance information (e.g., public, private, and uninsured) of the participants.

The MEPS data is collected through a series of five rounds of interviews that span a period of 2½ years. The interviews are conducted on a nationally representative sample of households using an overlapping panel design. Since the current study is conducted using a cross-sectional 2007 MEPS data, analytical adjustments were made using sample weights to accommodate the panel design. In complex survey designs, such as that used in MEPS, sample data must be multiplied by the appropriate sample weights to obtain

unbiased estimates for the US civilian non-institutionalized population. Sample weights provided within the MEPS data were used to estimate the national and regional expenditures of different health care service categories. The sample weights also account for equal representation of certain sections of the society which have been under represented in the surveyed population. These weights are also needed to correct for imperfections in the sample that might lead to bias and other departures between the sample and the reference population. Such imperfections include the selection of units with unequal probabilities, non-coverage of the population, and non-response.

The MEPS data includes the following three components:

1) *Household Component*: The Household Component (HC) is a national representative survey of the non-institutionalized civilian population. The structure and design of HC is very descriptive and provides detailed information on the population's demographic characteristics, health status, employment status, and their access to health care services. This component helps in understanding the complex research objectives such as the use of health services and expenditures, changes in provision of health care in relation to social and demographic factors and needs of a specific population group such as the elderly and children.

2) *Medical Provider Component*: The Medical Provider Component (MPC) is a survey of the medical providers, facilities, and pharmacies that provide health care services to individuals and families included in the survey. This component provides detailed information on the expenditure and payment sources of the respondents.

3) *Insurance Component*: The Insurance Component (IC) is designed to estimate the national and state-level cost of employer-sponsored coverage's. These estimates provide information on the amount spent, type of insurance, and cost of the job-related health insurance.

MEPS data provides information that can be useful in conducting a variety of research projects. Some examples include:

1) *Research on health care expenditure and their sources of payments*: MEPS data provides in-depth information on individual's total and out-of-pocket health care expenditures. The amount of health care services such as outpatient facility, inpatient, prescription drug, emergency room, and their sources of payment like Medicare, Medicaid, or private insurance can also be estimated.

2) *Research on vulnerable population groups*: The disparity in the utilization of health care resources and access to care among different population groups have been of immense concern to policymakers. MEPS data can provide valuable information to policy makers regarding the size and composition of a particular subset of population that are disadvantaged in terms of access and use of the various health care resources.

3) *Research on private and public health insurance*: MEPS data provides information on the health insurance status of the individuals and their family members. Additional insurance information such as premiums, employer and employee contributions, types of plans, and details on the scope and copayment provisions is available. The data is useful in estimating the health insurance in general, the interplay of specific insurance plans, and the use of health care resources.

The 2007 MEPS data contains variables and frequency distributions of 30,964 individuals who participated in the HC.

Study Population

The study population was divided into two cohorts based on the presence or absence of MSD's. Individuals with a primary diagnosis of conditions included under MSD's were selected. Table 1 lists all the disease conditions that are included under MSD's. The individuals categorized in the MSD cohort had ICD-9-CM codes of 278.00 and 710.00-738.00. Individuals without the MSD's codes were categorized into the non-MSD cohort.

Data Extraction

The 2007 consolidated full year file and medical conditions file were downloaded from the MEPS website (http://meps.ahrq.gov). The files were unzipped and decompressed to extract the data in ASCII format. The ASCII files were then converted to Predictive Analytical Software (PASW) version 18.0 with the help of SPSS load programs which were also downloaded from the MEPS website. The consolidated full year file and medical conditions file were then merged using the ICD-9-CM codes for MSD's (274.00 and 710.00-738.00).

Table 1: Disease conditions categorized under MSD's

ICD-9-CM	DISEASE CONDITION
274.00	Gout
710.00	Systemic lupus erythematosus
711.00	Arthropathy associated with infections
712.00	Crystal arthropathies
713.00	Arthropathy, endocrine disorders
714.00	Rheumatoid arthritis
715.00	Osteoarthrosis
716.00	Other & unspecified arthropathies
717.00	Internal derangement of knee
718.00	Other derangement of joint
719.00	Other & unspecified disorders of joint
720.00	Ankylosing spondylitis
721.00	Spondylosis & allied disorders
722.00	Intervertebral disc disorders
723.00	Other disorders of cervical region
724.00	Other & unspecified disorders of back
725.00	Polymyalgia rheumatica
726.00	Peripheral enthesopathies & allied syndromes
727.00	Other disorders of synovium, tendon, & bursa
728.00	Disorders of muscle, ligament, & fascia
729.00	Other disorders of soft tissues
730.00	Osteomyelitis, periostitis, & other infections
731.00	Osteitis deformans & osteopathies
732.00	Osteochondropathies
733.00	Other disorders of bone & cartilage
734.00	Flat foot
735.00	Acquired deformities of toe
736.00	Other acquired deformities of limbs
737.00	Curvature of spine
738.00	Other acquired musculoskeletal deformity

ICD-9 CM: The International Classification of Diseases Ninth Revision Clinical Modification

Based on the recommendation of the National Arthritis Workshop (1996)

Independent Variables

Presence of MSD's

The main variable was the presence of MSD's. In the MEPS data, the medical condition of the respondents was provided as ICD9CODX which was recoded into a new variable "MSD" and categorized as "Yes" and "No".

Census Region

This variable provides geographic information of the survey respondents. In the MEPS dataset, geographic region information was provided as REGION07. It was recoded into a new variable "Census Region". The patient's geographic region was categorized as: Northeast, Midwest, South, and West.

Age

This variable provides information on the age of a respondent and was reported as a continuous variable. In the MEPS dataset, age information was provided as AGE07X. This variable was recoded as "AGE IN YEARS", by dividing the sample into four categories 0-18 years, 19-40 years, 41-64 years, and 65 years and above.

Race

This variable provides information on the race of a respondent. In the MEPS dataset, race information was provided as RACEX. This variable was recoded as "RACE". In MEPS, the variable race was categorized into White, Black, Asian, Pacific Islander, Native American, and Mixed race.

Gender

This variable provides gender information of the survey respondents. In the MEPS dataset, gender information was provided as "SEX". The gender variable was categorized as male and female.

Education

This variable represented the education in years for the survey respondents. In MEPS, education years information was provided as EDUCYR. This variable was recoded as "EDUCATION YEARS". Education in years was originally recorded as a continuous variable and was recoded as categorical variables with three categories: less than 12 years of education, individuals with 12 years of education, and individuals with more than 12 years of education.

Marital Status

This variable provides information about the marital status of the survey respondents. In MEPS, marital status information was provided as MARRY07X. This variable was recoded as "MARITAL STATUS". This variable represents the marital status of an individual and was categorized as Married, Separated, Never Married, and under the age of 16 years.

Outcome Variables

Total Health Care Expenditures

This variable provides the total health care expenses and is useful in estimating the overall burden of MSD's on the health care system.

Total Office-based Chiropractor's Expenditures

This variable provides the office-based chiropractor's expenses. This expense is a part of the office-based expense which the individuals with MSD's incur.

Total Inpatient Facility Expenditures

This variable provides the inpatient facility expenses including procedures and drugs for the MSD's and the non-MSD population.

Total Outpatient Facility Expenditures

This variable provides the total outpatient facility expenses including physician and non-physician care visit charges for MSD's and non-MSD population.

Total Emergency Room Expenditures

This variable provides the total emergency room expenses for MSD's and non-MSD population.

*Total Prescription Drug Expenditure*s

This variable provides the total cost of prescription drugs for MSD's and non-MSD population.

Data Analysis

Data was analyzed using Predictive Analytical Software (PASW) version 18.0. As discussed earlier, national estimates from MEPS data was calculated by applying sample weights.

For all the regression models, a p-value of 0.05 was selected *a priori* as the significance level. For the analysis, a simple linear regression model was used:

$$Y = C + B_1X_1 + B_2X_2 \ldots\ldots + E$$

Y = Dependent variable, C= Intercept, B_1, B_2 = Beta coefficients, X_1, X_2 = Independent variables, E = Error component

The dependent variable in the regression model was the total expenditures for different service categories while the independent variable was the presence of MSD's. Age, gender, race, marital status, census region and education years were included as independent variables in the analysis. The model was based on the study by Balu and colleagues that estimated the incremental expenditure of hypertension.[36]

$$Expenditure = Intercept + B_1 Presence\ of\ MSD + B_2 Age + B_3 Gender + B_4 Race + B_5 Marital\ Status + B_6 Census\ region + B_7 Education\ years + E$$

Assumptions for Regression Model

The following assumptions were tested before the regression analyses were conducted and no serious violations of the assumptions were observed. Here the independent variables (IVs) refer to age, gender, race, marital status, census region,

education years and the dependent variables (DVs) refer to the total health care expenditures, total office-based chiropractor expenditures, total outpatient expenditures, total inpatient expenditures, total emergency room expenditures and total prescription expenditures.

Linearity of the relationship between the IV and the DV

If the relationship between IV and DV is not linear; the regression analysis results most likely under-estimate the true relationship. We conducted scatter plots of both IV and DV and found the relationship to be linear. In order to quantify the strength of the linear relationship, a numerical measure of association between the two variables was estimated using the correlation coefficient. A value between -1 and 1 indicated the strength of the association of the observed data for the two variables. Our results indicated that there was a strong linear relationship between the IVs and DVs since the coefficient correlation values were greater than 0.4.

Independence of errors to check for no serial correlation

Independence of the variables in a reported data is based on the assumption that all the variables recorded at the time of collection are independent. In order to determine the independence of variables, two tests were conducted. Tolerance is the proportion of a variable's variance that is not accounted for by the other IVs in the equation. A tolerance value close to 1 indicates very little multicollinearity, whereas a value close to 0 suggests that multicollinearity may be a threat. For this study, all the tolerance estimates were around 1 indicating very little or no multicollinearity. The second test to check for independence was the Variance Inflation Factor (VIF) which is the reciprocal of tolerance and quantifies the severity of multicollinearity in a regression analysis. The acceptable

range of VIF is a score less than 10. For this study, the VIF scores for all the IVs were less than 10, further indicating very little or no multicollinearity.

Homoscedasticity (assumption of constant variance)

The assumption of homoscedasticity is that the residuals are approximately equal for all predicted DVs scores. Homoscedasticity was tested by conducting scatter plots between each IV and DV. In the residual plots, the clusters of points were approximately the same width indicating that DVs exhibited similar amounts of variance across the range of values for the IVs.

Normality of the error distribution

The sample size in the 2007 MEPS data was 94,246. According to Central Limit Theorem, a sample distribution is approximately normal if the sample size is greater than 30. So the data was considered approximately normal. We still tested this assumption using two tests. Kurtosis is a measure of the shape of the probability distribution of a real-valued random variable. For a distribution to be normal, kurtosis scores should be within the range of -1 to +1. Study results were in the acceptable range of -1 to +1. Skewness was also conducted to check for normality. Skewness is a measure of the asymmetry of the probability distribution of a real-valued random variable. The acceptable range for skewness test is -1 to +1 for a normal distribution. The study results were also in the acceptable range. Both these tests confirmed the normality of the data.

Regression Analysis

For the regression analysis “Enter” Method was used. "Enter" method enters all variables into the regression model at the same time. This is the default method to conduct a regression analysis in SPSS. Other hierarchical methods that are used in regression models include “Backward”, “Forward”, and “Stepwise”. The hierarchical methods are used when specified order should reflect some theoretical consideration or previous findings. “Enter” method was selected for the analysis because there was no reason to believe that one variable is likely to be more important than another.

The following analyses were conducted based on the specific study objectives.

Objective 1: To identify the characteristics of the total population surveyed in 2007 MEPS data.

The frequencies for all the individuals in the database were assessed. The mean age was reported and the frequencies for age, gender, race, marital status, education years, and census region were analyzed. Sample survey weights were used to estimate the weighted and non-weighted prevalence of the MSD's.

Objective 2: To identify the demographic characteristics of individuals diagnosed with MSD's and non-MSD in 2007 MEPS data.

The frequencies for age, gender, race, educational years, marital status, and census region for the individuals with MSD’s was reported

In objectives 3, 4, and 5, the following regression model will be used for the estimation of costs.

$$Y = Intercept + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + B_7X_7 + E$$

where B_1-B_7 = Beta Coefficients; E = Error term; Dependent Variable = Expenditures; Independent Variables = Presence of MSD, Age, Gender, Race, Marital Status, Census Region, Education years.

$$Expenditure = Intercept + B_1Presence\ of\ MSD + B_2Age + B_3Gender + B_4Race + B_5Marital\ Status + B_6Census\ Region + B_7Education\ years + E$$

In the regression model, intercept is where the regression line strikes the Y axis when the independent variable has a value of 0. B_1 is the slope of the IV (e.g., presence of MSD's). Similarly B_2, B_3, B_4, B_5, B_6, B_7 are the slopes of other independent variables age, gender, race, marital status, census region, and education years, respectively. E is the error component in the estimation of the total cost. The predicted value is calculated as follows:

*Predicted variable (dependent variable) = slope * independent variable + intercept*

Objective 3: To estimate the mean expenditures for total health care expenditures, total office-based chiropractor's expenditures, total outpatient expenditures, total inpatient expenditures, total emergency room expenditures and total prescription expenditures in individuals with MSD's and non-MSD.

A separate dataset was created to calculate the mean expenditures in each service category for individuals with a MSD diagnosis. Descriptive analysis was conducted and

a linear regression model was utilized to estimate the mean total health care expenditures, mean total office-based chiropractor expenditures, mean total outpatient expenditures, mean total inpatient expenditures, mean total emergency room expenditures and mean total prescription expenditures. Certain independent variables were recoded as dummy variables to examine any possible effect of the categorical variable on the DV. The variables that were recoded were age, race, marital status, and education years.

The regression model used in the analysis was:

$$Expenditure = Intercept + B_1 Presence\ of\ MSD + B_2 Age + B_3 Gender + B_4 Race + B_5 Marital\ Status + B_6 Census\ Region + B_7 Education\ years + E$$

Objective 4: To identify the predictors for total health expenditures, total office-based chiropractor expenditures, total outpatient expenditures, total inpatient expenditures, total emergency room expenditures and total prescription expenditures in individuals with MSD's.

To identify the predictors of expenditures in each service category, a separate dataset was created that contained individuals with a MSD diagnosis alone. A linear regression model was utilized to estimate the mean total health care expenditures, mean total office-based chiropractor expenditures, mean total outpatient expenditures, mean total inpatient expenditures, mean total emergency room expenditures and mean total prescription drug expenditures. The model used was

$$Expenditure = Intercept + B_1 Presence\ of\ MSD + B_2 Age + B_3 Gender + B_4 Race + B_5 Marital\ Status + B_6 Census\ Region + B_7 Education\ years + E$$

Objective 5: To calculate a national estimate for the total incremental health care expenditures of MSD's compared to non-MSD.

To calculate a national estimate for the incremental health care expenditures for treating MSD's, mean cost of individuals with non-MSD diagnosis was conducted. A separate dataset with only individuals with non-MSD conditions were included. A linear regression model was run, using the "Enter" method. Cost of treatment under separate service category for the mean total health care expenditures, mean total office-based chiropractor expenditures, mean total outpatient expenditures, mean total inpatient expenditures, mean total emergency room expenditures and mean total prescription expenditures were calculated. The incremental difference between MSD's and non-MSD was calculated. The mean incremental difference was then multiplied by the prevalence of MSD's cases for the year 2007.

National estimate for the total incremental health care expenditures = National Prevalence × estimated incremental expenditures

Adjustment of Total and Incremental Costs to 2011 Values:

The costs from the 2007 MEPS data was inflated to year 2011 value by using the standardized inflation rates published by the Bureau of Labor Statistics (BLS).[37] This adjustment presents the economic burden of MSD's on the society in today's value.

CHAPTER FOUR

RESULTS

In this chapter, results for each of the study objectives are presented.

The full year consolidated data file and the medical component file of the 2007 MEPS data was utilized. From this dataset, patients were categorized as MSD's and non-MSD. Based on the National Arthritis Workshop recommendations, patients with ICD-9-CM codes of 274.00 and 710.00 to 738.00 as their primary diagnosis were categorized as having MSD's and the rest were categorized as non-MSD.[38] The 2007 MEPS database surveyed a total of 94,246 individuals. After the sample weights were applied, the national data represented 301,309,149 individuals.

Objective 1: To identify the characteristics of the total population surveyed in 2007 MEPS data.

A descriptive analysis was conducted to determine the frequencies (weighted and unweighted) of age, gender, race, education years, geographic region, and census region of the population surveyed in 2007 MEPS data (Refer Table 2). In the survey population (n=94,246), a majority of the respondents were under 18 years of age (30.8%) followed by 41 to 65 years (29.9%). The mean age of the respondents was 34.53±22.73 years (Mean±SD). There were 52.1% females and the survey population was predominantly white (74.5%), married (38.9%), with >12 years of education (44.9%), and from the Southern region of the US (38.0%).

Table 2: Characteristics of the total population surveyed in 2007 MEPS data.

Variable	level	Unweighted data N (%)	Weighted data N (%)
Age (years) (Mean±SD)		34.53±22.73	36.51±22.60
Age (years)	0 - 18	9,460 (30.8)	92,803,217 (31.0)
	19 - 40	8,803 (28.6)	86,174,416 (28.3)
	41-65	9,206 (29.9)	90,091,435 (30.2)
	> 66	3,278 (10.7)	32,240,078 (10.5)
Gender	Male	14, 817 (47.9)	144,327,082 (47.9)
	Female	16, 417 (52.1)	156,982,066 (52.1)
Race/ Ethnicity	White	23,705 (74.5)	224,475,316 (74.6)
	Black	5,404 (17.5)	52,729,101 (17.5)
	American Islander & Native Hawaiian	387 (1.2)	3,615,709 (1.2)
	Asian	1,442 (4.7)	14,161,530 (4.6)
	Mixed race	656 (2.1)	6,327,492 (2.1)
Census Region	Northeast	4,517 (14.7)	44,292,444 (14.7)
	Midwest	6,224 (20.2)	60,864,448 (21.1)
	South	11,699 (38.0)	114,497,476 (37.0)
	West	8,307 (27.0)	81,353,470 (27.2)
Marital Status	Married	12, 044 (38.9)	117,209,259 (38.0)
	Separated	4,417 (14.3)	43,087,208 (15.0)
	Never Married	6,600 (21.3)	64,178,848 (21.5)
	Under 16 years of age	7,893 (25.5)	76,833,833 (25.5)
Education Years	<12 years	4,656 (22.4)	67,493,249 (22.5)
	12 years	6, 812 (32.7)	98,528,091 (32.5)
	> 12 years	9,336 (44.9)	135,287,807 (45.0)

N = Number of individuals

SD = Standard deviation

Objective 2: To identify the demographic characteristics of individuals diagnosed with MSD's and non-MSD in the 2007 MEPS data.

Among the surveyed individuals (n= 94, 246), 10, 696 (11.3%) were categorized as MSD's and the rest were categorized as non-MSD (n= 83,550; 88.7%). The weighted national population of MSD's and non-MSD were 33,075,541 (11.3%) and 268,233,608 (88.7%), respectively.

The mean ages for individuals with MSD's and non-MSD were 34.63±22.99 years and 34.51±22.70 years, respectively. In the MSD's and non-MSD cohort, a majority of the individuals were under 18 years of age (31.1%, 30.7%) followed by 41 to 65 years (30.0%, 29.9%). Females (52.1%, 52.2%), whites (75.1%, 74.4%), individuals with >12 years of education (43.4%, 45.1%), and Southern region of the US (38.6%, 38.0%) were predominant among both the MSD's and non-MSD cohort.

Table 3: Demographic characteristics of MSD's and non-MSD in the 2007 MEPS data.

Variable	Level	MSD N (%)	Non-MSD N (%)	P-value
Age (years) (Mean±SD)		34.63±22.99	34.51±22.70	0.782*
Age (years)	0-18	1,071(31.1)	8,389 (30.7)	0.778**
	19-40	960 (27.9)	8,175 (28.7)	
	41-65	1,031(30.0)	8,175 (29.9)	
	>66	379 (11.0)	2,899 (10.6)	
Gender	Male	1,662 (47.9)	13,155 (47.8)	0.929**
	Female	1,806 (52.1)	14,341 (52.2)	
Race/Ethnicity	White	2,605 (75.1)	20,470 (74.4)	0.920**
	Black	596 (17.2)	4,808 (17.5)	
	Native American & Hawaiian Islander	41 (1.1)	346 (1.2)	
	Asian	157 (4.5)	985 (3.6)	
	Multiple Races	69 (1.9)	587 (2.1)	
Census Region	Northeast	483 (14.0)	4,034 (14.8)	0.681**
	Midwest	703 (20.4)	5,521 (20.2)	
	South	1,328 (38.6)	10,371 (38.0)	
	West	927 (26.9)	7,380 (27.0)	
Marital Status	Married	1,324 (38.2)	10,720 (39.0)	0.632**
	Separated	484 (14.0)	3,933 (14.3)	
	Never Married	757 (21.8)	5,843 (21.3)	
	Under 16 years of age	903 (26.0)	6,990 (25.4)	
Education Years	< 12 years	538 (23.1)	4,118 (22.3)	0.323**
	12 years	779 (33.5)	6,033 (32.6)	
	>12 years	1,011(43.4)	8,325 (45.1)	

N= Number of individuals, SD = Standard deviation, *Independent t-test , ** Chi-square test, Significance at $p \leq 0.05$

Objective 3: To estimate the mean expenditures for total health care expenditures, total office-based expenditures, total outpatient expenditures, total inpatient expenditures, total emergency room expenditures, total office-based chiropractor expenditures, and total prescription expenditures in individuals with MSD's and non-MSD.

In order to estimate the cost of treatment for different service categories, two separate datasets were created. The first dataset contained individuals with a diagnosis of MSD's. All the other individuals without the MSD diagnosis were included into the non-MSD dataset. A multiple linear regression was conducted to estimate the mean health care expenditures for individuals with MSD's and non-MSD under different service categories like total health care expenditures, office-based expenditures, outpatient expenditures, inpatient expenditures, emergency room expenditures, office-based chiropractor expenditures, and prescription expenditures. The regression model used for the two cohorts was:

$$Expenditure = Intercept + B_1 Presence\ of\ MSD + B_2 Age + B_3 Gender + B_4 Race + B_5 Marital\ Status + B_6 Census\ Region + B_7 Education\ years + E$$

where B_1-B_7 *= Beta Coefficients*

E *= Error term*

Dependent Variable = Expenditure

Independent Variables = Presence of MSD, Age, Gender, Race, Marital Status, Census Region, Education years

The mean total health care expenditures for the MSD's cohort were $91,121.41 compared to $90,234.91 for the non-MSD cohort ($p \leq 0.05$). The non-zero confidence

interval suggested that there was a significant difference between the cost estimates of the two cohorts. In both MSD's and non-MSD, inpatient facility expenditures were the highest ($33,461.85; $30,798.62) followed by prescription drug expenditures ($26,384.35; $25,651.44), and office-based expenditures ($16,338.80; $16,834.81). The emergency room expenditures and the office-based chiropractor expenditures made smaller contributions to the overall health care expenditures in both the cohorts.

Similar to the total health care expenditures, expenditures for each service category was estimated. Table 4 represents the parameter estimates for each IV in both the cohorts. The mean expenditures for each service category were calculated using the parameter estimates for each respondent as follows:

*Beta coefficient * IV + Intercept = Mean cost under each service category…….. (1)*

For example, the total health care expenditures for a respondent were calculated as:

Total health care expenditure$_{individual}$ = 683.144-595.26(sex)-447.1*(census region) +128.31*(marital status)-409.11*(race) +2795.348*(age)-652.576*(education years)*

Substituting the values of IVs for each respondent in the above equation, the total health care expenditures were calculated as:

Total health care expenditures$_{individual}$ = 683.144-595.26(2)-447.1*(3) +128.31*(6)-409.11*(1) +2795.348*(9)-652.576*(2) = $198,532.31*

The sum of the total health care expenditures for all the respondents with MSD's gave the total health care expenditures of the MSD's cohort. Similarly, the total health care expenditures for the non-MSD cohort were calculated. Table 5 presents the mean expenditures for the different service categories in the MSD's and non-MSD cohort.

Table 4. Parameter estimates for different service categories in MSD's and non-MSD cohorts

Independent variables	Total health care expenditures				Total inpatient facility expenditures				Total prescription drug expenditures			
	MSD's		Non-MSD		MSD's		Non-MSD		MSD's		Non-MSD	
	B	C.I	B	C.I.	B	C.I.	B	C.I.	B	C.I.	B	C.I.
Intercept	683.144	-4906.05 - 6272.33*	-3503.218	-4869.27 - -2137.51*	1568.623	-1919.39 - 5056.64	-1238.852	-2210.14 - -267.56*	-1350.303	-1967.59 - -733.07*	-1217.826	-1509.15 - -926.51*
Gender	-595.263	-1973.40 - 782.87	779.481	446.05 - 1112.94*	-592.237	-1452.28 - 267.81	11.308	-225.79 - 248.40	162.009	9.80 - 314.01*	184.832	113.71 - 255.94*
Census Region	-447.129	-1130.47 - 235.82	20.798	-141.08 - 182.67	-337.563	-763.76 - 88.64	84.408	-30.69 - 199.50	-45.780	-121.20 - 29.64	-8.524	-43.04 - 25.99
Marital Status	128.131	-754.08 - 1010.34	229.673	17.56 - 441.78*	1.102	-549.45 - 551.65	94.769	-56.04 - 245.45	153.642	56.20 - 251.07*	92.071	46.84 - 137.30*
Education Status	-409.115	-1548.98 - 730.75	-480.639	-762.05 - - 199.24*	-364.159	-1075.71 - 347.19	-287.762	-487.83 - 87.86	-67.068	-192.96 - 58.82	-129.102	-189.10 - -69.09*
Age	2795.348	1756.50 - 3834.29	2788.223	2543.21 - 3042.25*	1078.377	430.00 - 1726.07*	125.053	803.75 - 1164.96*	803.876	689.13 - 918.62*	799.680	745.51 - 853.84*
Race/ Ethnicity	-652.576	-1493.21 - 188.06	-16.529	-210.59 - 177.54	-214.531	-738.96 - 310.26	984.362	-12.93 - 263.04	-96.367	- 189.21 - -3.52*	-43.489	-84.87 - -2.10

Table 4 (continued). Parameter estimates for different service categories in MSD's and non-MSD cohorts

Independent variables	Total outpatient facility expenditures				Total office-based expenditures				Total office-based chiropractors expenditures				Total ER facility expenditures			
	MSD's		Non-MSD		MSD's		Non-MSD		MSD's		Non-MSD		MSD's		Non-MSD	
	B	C.I.	B	C.I.	B	C.I.	B	C.I.	B	C.I.	B	C.I.	B	C.I.	B	C.I.
Intercept	-73.443	-536.35 - 389.44	60.054	-162.08 - 282.13	666.763	-1322.05 - 2655.73	-597.631	-1108.26 - -86.99	-37.799	-123.63 - 48.03	-71.590	-116.20 - -27.16*	155.700	-172.98 - 484.38	73.548	0.022 - 147.07*
Gender	-31.637	-147.55 - 82.50	52.891	-1.32 - 107.10	-81.632	-572.05 - 408.79	339.841	215.90 - 464.49*	12.176	-8.93 - 33.43	7.807	-3.03 - 18.65	42.515	-38.53 - 123.58	0.456	-17.49 - 18.40
Census Region	22.300	-34.26 - 78.86	-41.448	-67.76 - -15.13*	-108.633	-351.66 - 134.40	-24.550	-85.08 - 35.89	11.749	1.23 - 22.24*	0.399	-4.86 - 5.66	2.251	-37.91 - 42.71	3.947	-4.76 - 12.66
Marital Status	-6.525	-79.59 - 66.54	-28.571	-63.05 - 5.91	-97.974	-411.91 - 215.96	-12.493	-92.22 - 66.43	-1.109	-14.56 - 12.52	9.700	2.80 - 16.52*	-25.205	-77.08 - 26/67	-2.624	-14.04 - 8.79
Education Status	-23.767	-118.17 - 70.64	-15.199	-60.94 - 30.54	27.232	-378.40 - 432.86	-0.206	-105.39 - 104.98	1.006	-16.45 - 18.52	21.588	12.43 - 30.74	-44.374	-111.40 - 22.60	-11.799	-26.94 - 3.34
Age	170.328	84.28 - 256.36*	159.265	117.97 - 200.56*	476.368	106.64 - 846.08*	494.470	399.51 - 589.42*	7.544	-8.41 - 23.69	12.640	4.37 - 20.90*	22.650	-38.44 - 83.47	22.783	9.11 - 37.45*
Race/ Ethnicity	-54.852	-124.47 - 14.77	-22.788	-54.338 - 8.76	-216.870	-516.19 - 82.28	-25.927	-98.47 - 46.61	-3.369	-16.27 - 9.54	-5.983	-12.29 - 0.325	-18.687	-68.12 - 30.74	-0.979	-11.43 - 9.46

MSD = Musculoskeletal disorders, Non-MSD = Non musculoskeletal disorders, B = intercept, C.I . = Confidence interval, * Significant at $p \leq 0.05$

Table 5. Mean expenditures for different service categories in MSD's and non-MSD cohorts in the 2007 MEPS data.

Mean Expenditures	MSD's	Non-MSD
Total health care expenditures	$91,121.41	$90,234.91
Office-based expenditures	$16,338.80	$16,834.81
Inpatient facility expenditures	$33,461.85	$30,798.62
Outpatient facility expenditures	$3,573.41	$5,252.28
Emergency room expenditures	$493.50	$750.99
Prescription drug expenditures	$26,384.35	$25,651.44
Office-based chiropractor expenditures	$209.97	$603.23

MSD's = Musculoskeletal disorders

Non-MSD = Non musculoskeletal disorders

Objective 4: To identify the predictors of total health care expenditures, total office-based expenditures, total outpatient expenditures, total inpatient expenditures, total emergency room expenditures, total office-based chiropractor's expenditures, and total prescription expenditures in individuals with MSD's.

Multiple regressions were conducted to identify factors that predicted the health care expenditures in MSD's. A total of seven regression models were set up to estimate the predictors of the different service categories and the DVs were the health care expenditures in each service category. The IV was the presence of MSD's. Since age, gender, race, census region, marital status, and education years are categorical variables, dummy variables for each of these variables were created and added to the regression model as IVs. Table 6 reports the regression analysis for total health care expenditures in MSD's. Age (41 to 65 years and 66 years and above), census region of the US (South) and marital status (under 16 years) were significant predictors of total health care expenditures for MSD's.

Table 6. Predictors of the total health care expenditures for MSD's in 2007 MEPS data.

Model		B	SE	CI		Sig. (*p*)
Variables	Levels			Lower Bound	Upper Bound	
Presence of condition	MSD	5782.46	1423.58	2991.26	8573.66	.000*
	No MSD†					
Sex	Male	-476.99	508.96	-1474.86	520.96	.349
	Female†					
Age in years	0 to 18†					
	19 to 40	-2428.80	1350.17	-5076.06	218.47	.072
	41 to 65	645.71	1436.04	-2169.91	3461.32	.000*
	66 and above	4323.47	1534.69	1314.42	7332.56	.005*
Race	White†					
	Black	-614.08	785.30	-2153.80	925.61	.434
	American Islanders & Native American	-788.85	2527.80	-5745.15	4167.45	.755
	Asian	-2179.24	1826.36	-4701.38	342.90	.090
	Multiple race	-186.23	1854.98	-3823.68	3450.79	.920
Education Years	<12 years†					
	12 years	-342.84	841.33	-1992.43	1306.74	.684
	>12 years	564.032	798.84	-1002.25	2130.31	.480
Census Region	Northeast†					
	Midwest	380.38	806.78	-1201.48	1962.23	.637
	South	-1656.14	729.83	-3086.23	-226.05	.023*
	West	-1253.22	803.44	-2828.51	322.07	.119
Marital Status	Married†					
	Separated	-155.99	782.83	-1690.87	1378.88	.842
	Never Married	-1145.85	775.70	-2666.76	375.06	.140
	Under 16	-3167.32	1429.39	-5969.92	-364.72	.027*

† Reference group, B: Intercept, SE: Standard Error, C.I: Confidence Interval, R Squared = .072, $p \leq 0.05$

Table 7 reports the regression analysis for total office-based expenditures in MSD's. Age group (66 years and above) was the significant predictor of total office-based expenditures for MSD's.

Table 8 reports the regression analysis for total prescription drug expenditures in MSD's. Gender (male), age (41 to 65 years and 66 years and above), and census region of the US (Northeast) were significant predictors of total prescription drug expenditures for MSD's.

Table 9 reports the regression analysis for total inpatient facility expenditures in MSD's. Age (19 to 40 years), census region of the US (south and west), and marital status (under the age of 16 years) are significant predictors of total inpatient facility expenditures for MSD's.

Table 10 reports the regression analysis for total emergency room expenditures in MSD's. None of independent variables were significant predictors of total ER expenditures for MSD's.

Table 11 reports the regression analysis for total outpatient facility expenditures in MSD's. Age (41 to 65 years) and census region of the US (Midwest) were significant predictors of total outpatient facility expenditures for MSD's.

Table 12 reports the regression analysis for total office-based chiropractor expenditures in MSD's. Age (66 years and above), and marital status (separated) were significant predictors of total office-based chiropractors expenditures for MSD's.

Table 7. Predictors of the total office-based expenditures for MSD's in 2007 MEPS data

Model		B	SE	CI		Sig. (*p*)
Variables	Levels			Lower Bound	Upper Bound	
Presence of condition	MSD	804.15	501.18	-178.50	1786.80	.109
	No MSD†					
Sex	Male	-80.72	179.18	-432.04	270.60	.652
	Female†					
Age in years	0 to 18†					
	19 to 40	-161.43	475.33	-1092.43	770.55	.734
	41 to 65	530.05	505.56	-461.19	1521.30	.295
	66 and above	1348.59	540.29	289.24	2407.93	.013*
Race	White†					
	Black	-236.68	276.47	-778.74	305.39	.392
	American Islanders & Native American	-346.84	889.93	-2091.72	1398.04	.697
	Asian	-633.26	452.86	-1521.90	254.66	.162
	Multiple race	-354.19	653.05	-1634.61	926.23	.588
Education Years	<12 years†					
	12 years	-4.26	296.19	-585.00	576.48	.989
	>12 years	440.17	281.23	-111.24	991.58	.118
Census Region	Northeast†					
	Midwest	376.79	284.03	-180.10	933.69	.185
	South	-280.04	256.78	-783.51	223.42	.276
	West	-153.31	282.85	-707.90	401.27	.588
Marital Status	Married†					
	Separated	-464.82	275.59	-1004.46	76.08	.092
	Never Married	-362.07	273.08	-897.51	173.36	.185
	Under 16	-305.45	503.24	-1292.12	681.20	.544

† Reference group, B: Intercept, SE: Standard Error, C.I: Confidence Interval, R Squared = .191, $p \leq 0.05$

Table 8. Predictors of the total prescription drug expenditures for MSD's in 2007 MEPS data

Model		B	SE	CI		Sig. (*p*)
Variables	Levels			Lower Bound	Upper Bound	
Presence of condition	MSD	205.08	165.883	-120.16	530.32	.216
	No MSD†					
Sex	Male	150.12	59.30	33.83	226.40	.011*
	Female†					
Age in years	0 to 18†					
	19 to 40	-45.99	157.32	-354.46	262.48	.770
	41 to 65	868.54	167.33	358.45	1014.62	.000*
	66 and above	1713.17	178.83	1362.54	2063.80	.000*
Race	White†					
	Black	-31.63	91.50	-211.5	147.78	.730
	American Islanders & Native American	-110.39	294.55	-687.92	467.14	.708
	Asian	-211.69	149.89	-505.59	82.19	.158
	Multiple race	-315.94	216.15	-739.75	107.85	.144
Education Years	<12 years†					
	12 years	23.32	98.03	-168.89	215.51	.812
	>12 years	120.62	93.08	-61.89	303.13	.195
Census Region	Northeast†					
	Midwest	95.37	94.01	-88.95	279.69	.310
	South	35.14	84.99	-131.50	210.78	.679
	West	187.94	93.62	-371.50	-4.382	.045*
Marital Status	Married†					
	Separated	84.86	91.21	-93.98	263.71	.352
	Never Married	43.23	90.38	-133.98	220.46	.632
	Under 16	-96.68	166.56	-423.25	229.89	.562

† Reference group, B: Intercept, SE: Standard Error, C.I: Confidence Interval, R Squared = .131, $p \leq 0.05$

Table 9. Predictors of the total inpatient facility expenditures in for MSD's 2007 MEPS data

Model		B	SE	CI		Sig. (*p*)
Variables	Levels			Lower Bound	Upper Bound	
Presence of condition	MSD	3949.42	903.29	2178.34	5720.90	.000*
	No MSD†					
Sex	Male	-440.78	322.95	-1073.99	192.42	.172
	Female†					
Age in years	0 to 18†					
	19 to 40	-1773.46	856.71	-3413.07	-53.57	.001*
	41 to 65	-764.58	911.19	-2551.15	1021.99	.401
	66 and above	790.48	973.98	-1118.26	2699.80	.417
Race	White†					
	Black	-184.07	911.18	-1161.07	792.91	.712
	American Islanders & Native American	-109.56	1603.97	-3254.4	3033.32	.946
	Asian	-972.62	816.22	-2572.91	627.73	.233
	Multiple race	527.31	1177.02	-1780.46	2835.09	.654
Education Years	<12 years†					
	12 years	-392.83	533.84	-1439.53	653.83	.462
	>12 years	-87.41	506.88	-1081.25	906.42	.863
Census Region	Northeast†					
	Midwest	-480.68	511.92	-1844.41	523.03	.348
	South	-1356.50	462.81	-2263.93	-449.07	.003*
	West	-1198.53	509.80	-2198.09	-198.07	.002*
Marital Status	Married†					
	Separated	182.58	496.72	-791.32	1156.50	.713
	Never Married	-927.74	492.20	-1892.80	37.30	.060
	Under 16	-2344.68	906.86	-4123.00	-566.37	.001*

† Reference group, B: Intercept, SE: Standard Error, C.I: Confidence Interval, R Squared = .181, $p \leq 0.05$

Table 10. Predictors of the total ER facility expenditures for MSD's in 2007 MEPS data

Model		B	SE	CI		Sig. (*p*)
Variables	Levels			Lower Bound	Upper Bound	
Presence of condition	MSD	76.45	88.23	-96.53	249.5	.386
	No MSD†					
Sex	Male	22.87	31.54	-38.97	84.72	.468
	Female†					
Age in years	0 to 18†					
	19 to 40	59.83	83.68	-104.20	223.90	.475
	41 to 65	102.79	89.00	-71.71	277.30	.248
	66 and above	74.38	95.11	-112.11	260.87	.782
Race	White†					
	Black	-10.49	48.67	-105.92	84.93	.829
	American Islanders & Native American	-84.59	156.67	-391.78	222.59	.589
	Asian	-56.48	79.72	-212.80	99.83	.479
	Multiple race	-60.78	114.96	-286.12	164.71	.598
Education Years	<12 years†					
	12 years	15.01	52.14	-87.22	117.35	.773
	>12 years	-96.49	49.51	-193.57	.577	.051
Census Region	Northeast†					
	Midwest	1.871	50.04	-96.17	99.91	.970
	South	16.55	45.20	-72.07	105.19	.714
	West	2.59	49.76	-95.04	100.22	.958
Marital Status	Married†					
	Separated	-3.42	48.51	-98.55	91.70	.944
	Never Married	1.20	48.07	-93.05	95.47	.980
	Under 16	-48.06	88.59	-221.76	125.64	.588

† Reference group, B: Intercept, SE: Standard Error, C.I: Confidence Interval, R Squared = .050, $p \leq 0.05$

Table 11. Predictors of the total outpatient facility expenditures in 2007 for MSD's

Model		B	SE	CI		Sig. (*p*)
Variables	Levels			Lower Bound	Upper Bound	
Presence of condition	MSD	106.81	122.38	-133.72	346.13	.386
	No MSD†					
Sex	Male	-23.69	43.75	-109.48	62.09	.588
	Female†					
Age in years	0 to 18†					
	19 to 40	-46.69	116.07	-274.22	180.93	.688
	41 to 65	152.33	123.45	-89.71	394.38	.217
	66 and above	372.57	131.93	113.89	631.25	.005*
Race	White†					
	Black	-66.28	67.51	-198.64	66.08	.326
	American Islanders & Native American	-73.75	217.31	-499.84	352.32	.734
	Asian	-167.62	110.58	-384.44	49.19	.130
	Multiple race	-7.57	159.46	-320.24	305.09	.962
Education Years	<12 years†					
	12 years	44.03	72.32	-97.78	185.84	.543
	>12 years	44.48	68.67	-90.16	179.13	.517
Census Region	Northeast†					
	Midwest	136.798	69.358	.809	272.86	.049*
	South	-11.93	62.70	-134.93	110.94	.848
	West	103.08	69.07	-32.34	238.50	.136
Marital Status	Married†					
	Separated	-64.98	67.29	-196.93	66.96	.334
	Never Married	-52.52	66.86	-183.27	78.20	.431
	Under 16	-98.51	122.88	-339.44	142.41	.423

† Reference group, B: Intercept, SE: Standard Error, C.I: Confidence Interval, R Squared = .091, $p \leq 0.05$

Table 12. Predictors of the total office based chiropractor expenditures in 2007 for MSD's

Model		B	SE	CI		Sig. (*p*)
Variables	Levels			Lower Bound	Upper Bound	
Presence of condition	MSD	26.06	26.83	-34.41	85.59	.382
	No MSD†					
Sex	Male	2.79	10.66	-18.12	30.70	.794
	Female†					
Age in years	0 to 18†					
	19 to 40	19.62	28.56	-35.84	75.12	.488
	41 to 65	18.54	30.09	-40.06	70.99	.538
	66 and above	79.14	32.16	16.10	142.61	.014*
Race	White†					
	Black	-13.48	16.45	-45.78	18.72	.413
	American Islanders & Native American	53.00	52.90	-50.80	156.88	.317
	Asian	8.40	26.93	-61.20	44.34	.755
	Multiple race	-22.40	38.79	-98.61	58.44	.564
Education Years	<12 years†					
	12 years	-13.10	17.66	-47.62	21.44	.457
	>12 years	-9.88	16.45	-42.67	22.95	.566
Census Region	Northeast†					
	Midwest	-2.07	16.91	-35.22	31.22	.903
	South	-19.20	15.21	-49.10	10.72	.209
	West	7.53	16.80	-25.41	40.21	.654
Marital Status	Married†					
	Separated	-33.74	16.43	-65.91	-1.57	.040*
	Never Married	-8.76	16.2	-40.63	8.23	.589
	Under 16	-11.98	29.65	-70.71	46.70	.690

† Reference group, B: intercept, SE: Standard Error, C.I: Confidence Interval, R Squared = .080, $p \leq 0.05$

Objective 5: To calculate a national estimate for the total incremental health care expenditures of MSD's compared to the non-MSD cohort.

Incremental cost analysis is a decision-making technique used to determine the true cost difference between alternatives. To calculate a national estimate for the incremental health care expenditures for treating MSD's, mean cost of individuals with non-MSD diagnosis was conducted. A separate dataset of individuals with non-MSD was created and a linear regression model was run, similar to the MSD's cohort. The cost of treatment under different service categories was then calculated. The incremental difference was calculated by subtracting the mean total cost per service category of non-MSD from that of the MSD's.

The regression model used is as follows:

$$Expenditure = Intercept + B_1 Presence\ of\ MSD + B_2 Age + B_3 Gender + B_4 Race + B_5 Marital\ Status + B_6 Census\ Region + B_7 Education\ years + E$$

For a national estimate for each service category, the mean incremental difference was multiplied by the prevalence of MSD's cases for the year 2007:

National Estimate = Incremental cost of MSD x Prevalence of MSD

The 2007 estimate was inflated to present day value (2011) by multiplying the 2007 costs estimate with the 2011medical inflation rates reported by the BLS.[37] The proportional increase in 2011 costs was calculated using the formula:

2011 costs =2007 costs(2011 index value /2007 index value) =2007 costs * (400.258/351.054)*

The prevalence of MSD's was assumed to be the same for 2007 and 2011. Table 13 presents the mean incremental cost difference and the national estimates for different service categories for both 2007 and 2011.

Table 13. Incremental and national cost estimates for MSD's compared to non-MSD

Service category	Mean expenditures		Incremental cost		National Estimates	
	MSD's	Non-MSD	2007	Inflated 2011 value	2007	Inflated 2011 value
Total health care expenditures	$91,121.41	$90,234.91	$886.49	$1010.74	$30.25 billion	$35.61 billion
Total emergency room expenditures	$493.50	$750.99	$257.49*	$293.57	$8.71 billion	$10.34 billion
Total office-based chiropractor expenditures	$209.97	$603.23	$393.27*	$448.32	$13.40 billion	$15.79 billion
Total office-based expenditures	$16,338.80	$16,834.81	$496.01*	$565.45	$16.92 billion	$19.92 billion
Total prescription drug expenditures	$26,384.35	$25,651.44	$732.91	$835.51	$25.01 billion	$29.43 billion
Total outpatient facility expenditures	$3,573.41	$5,252.28	$1678.87*	$1913.91	$57.29 billion	$67.43 billion
Total inpatient facility expenditures	$33,461.85	$30,798.62	$2663.22	$3036.06	$90.80 billion	$106.97 billion

The national prevalence of MSD's in 2007 was 11.3%. The prevalence rate was assumed to be the same in 2011.

US Population in 2007 = 302,000,000

US Population in 2011= 311,811,000

* Negative increment for MSD's

Inflated value calculated by multiplying the costs with a ratio of 2011 index value (400.258) and 2007 index value (351.054)

CHAPTER FIVE

DISCUSSION AND CONCLUSIONS

This study utilized the HC and the MPC from the 2007 MEPS data to study the demographics, prevalence estimates, and cost estimates of MSD's. Specifically, the study estimated the total health care expenditures in MSD's and the costs of different service categories including total inpatient facility expenditures, total outpatient facility expenditures, total prescription drug expenditures, total office-based chiropractors expenditures, total office based expenditures, and total emergency room facility expenditures. The study also estimated the incremental costs of MSD's compared to non-MSD and identified the predictors associated with these cost estimates.

In 2007 MEPS data, 94,246 individuals were surveyed and this translated into a weighted national population of 301,309,149. Of the total weighted population, 11.3% had a primary diagnosis of MSD's. As per our study, in 2007 approximately 34.8 million people suffered from a primary musculoskeletal condition. Since MEPS data only provides primary diagnoses, this prevalence rate is an underestimate and will likely be higher if both primary and secondary diagnosis for MSD's are considered.

Very few studies have reported the prevalence data for MSD's in the US. Yelin et al. (1996) reported that 4,161 individuals (unweighted) had a primary or secondary musculoskeletal conditions with 53.935 million individuals nationwide (20.1% of the population) reporting at least one musculoskeletal condition.[32] Another study using the 2004-2005 National Health Interview Survey (NHIS) estimated a total of 110.8 million

individuals with a primary or a secondary musculoskeletal condition.[3] In yet another MEPS data study, the prevalence of MSD in the US population was reported as 10.6% in 2006.[39]

Based on the data from the last decade, there seems to be an upward trend in the prevalence of MSD's in the US. One of the most commonly cited reason for this trend is the increase in the aging population in the US.[3] Other reasons that are responsible for the increase in prevalence include the burden of other chronic disorders, life style changes, and increasing life expectancy.[3] Contrary to the popular belief that MSD's are common in aging population; in this study, high prevalence was also seen in the age categories of 0-18 years and 19-40 years. Some potential explanations for the increased prevalence in these age groups could be due to the nature of work activities that require physical stress (e.g., sports, heavy labor intensive jobs).[3] Thus, the prevalence of MSD's in the elderly seem to be a chronic condition and is also prevalent in the young adults, although as an acute condition.

The demographic analysis of the 2007 MEPS data revealed a higher prevalence of MSD's in females (52.1%) compared to the males (47.9%). This finding is consistent with those reported by other studies. Wijnhoven et al. (2006) presented an overview of gender differences in musculoskeletal pain and presented data obtained from two general population-based prospective surveys administered in a Dutch population. Study reported that females experienced MSD's at a higher rate (45%) than males (39%).[39] Based on epidemiologic data, females tend to have higher incidences of rheumatic conditions than males.[39] A number of reasons are cited for the higher prevalence in females including hormonal changes, genetic differences, and lifestyle differences

between the two genders. Females experience both exogenous changes in hormonal levels (e.g., due to oral contraceptive pill) and endogenous changes (particularly related to menstruation and pregnancy history). The genetic influence could either be direct i.e., influence of genes on sex chromosomes or indirect i.e., microchimerism.[40]

The data was analyzed to study the prevalence of MSD's by the census region of the US. A majority of individuals with MSD's were from the South (38.6%) followed by the West (26.9%), Midwest (20.4%), and Northeast (14%). A number of reasons can possibly explain this trend. The higher obesity rates in the southern part of the US are considered a major contributor to the increased prevalence of MSD's in this region.[41] Genetic reasons are also cited for the increased incidence of MSD's.[42] Hundreds of genes are involved in making proteins that protect muscle fibers from damage. Muscular dystrophy leading to MSD's occurs when one of these genes is defective. Each form of muscular dystrophy is caused by a genetic mutation that's particular to that type of the disease. Many of these mutations are inherited, but some occur spontaneously in the mother's egg or in the developing embryo.[42] Environmental influence is another major factor responsible for MSD's cases. Workers in the colder region have high prevalence of MSD's, especially of the lower back and shoulders. Cold weather has shown to increase the risk of muscle strain resulting in tense muscle tissues, which are susceptible to injuries.[43]

In the literature, MSD's are commonly reported as the disease of the "Whites" since the prevalence is always higher in Whites than in other races.[44] Consistent results were seen in our study (Whites -75.1%; Blacks - 17.1%) although we have to be careful in drawing our conclusions based on the surveyed individuals given the over sampling of

Whites in 2007 MEPS data. However, since the data was adjusted with sample weights, we are confident that the weighted results are much more reflective of the national prevalence data.

The data was analyzed to study the prevalence of MSD's by marital status. Majority of the individuals with MSD's were married (38.2%) and this observation can be explained by the fact that married workers have several non-occupational responsibilities such as cleaning, washing, taking care of their spouse and children, to name a few, which exposes them to more ergonomic stressors than those who are not married.[45]

The study also analyzed the prevalence of MSD's based on the years of education of an individual. The study results are similar to the previous findings that individuals with 12 years or less of education had the highest prevalence of MSD's.[46] This is primarily due to the fact that individuals with less education are less aware of the MSD's and the factors that lead to MSD's. Also, poor understanding of the disease and its processes has been observed in individuals who are less educated.[46] Additionally, those with less education are more likely to be involved in labor-intensive jobs.[47]

The study estimated the mean total health care expenditures at $91,121.41 with an estimated incremental societal burden of $30.25 billion in the US in 2007. The high costs of MSD's could be attributed to the growing number of aging population and younger individuals affected by the condition and the use of biologics in the treatment of MSD's. For treating individuals with MSD's, both invasive and non-invasive procedures are conducted. Some procedures like hip replacements or joint surgeries are extensive and

involve extended care at a live-in facility. Also, the annual medication expenditures for treatment of RA and AS with the new biologic drugs can be as high as $15,000 - $20,000 per patient which significantly increases the costs burden of the disease.[40] Additionally, if individuals with both primary and secondary diagnosis of MSD's condition are considered and the indirect cost (e.g., loss in productivity) is calculated, the overall burden of MSD's on the society will be enormous.

The study compared the different service category costs in MSD's with those of non-MSD. From our analysis, we found that there is a significant burden of MSD's due to the inpatient expenses. Analysis suggested that there was a mean $2,663.20 incremental burden of MSD over non-MSD individuals. Taking into account the total US population for the year 2011, the overall annual expenditures due to inpatient facility expenditure of the MSD's in the US was approximately $106.97 billion. A study by Osborne et al. suggested that MSD's was responsible for the 6th largest inpatient visits in the US followed by renal dialysis, general surgery, obstetrics, gastroenterology, and general medicine.[48] As suggested earlier, a possible reason for increased inpatient expenditures could be due to the use of invasive and non-invasive procedures such as joint surgeries, corticosteroid injections, anesthetic injections, and dry needling etc.[49] Secondly, with the increase in aging population, there is an increased utilization of these procedures, which leads to increased total inpatient facility expenditures for MSD's. Preventive steps such as early detection of the disease and screening programs, laboratory tests like alkaline phosphatase and RA factor test are needed to limit the inpatient facility cost as the number of individuals with MSD's is increasing and the demand for inpatient services are growing. For example, individuals should be regularly screened using

techniques like x-rays, ultrasound, and MRI for symptoms related to MSD's and should be treated at a level where inpatient procedures are not required. These screening procedures, although expensive, have been very effective in lowering the cost of treatment for disease conditions like diabetes mellitus in the long run.[28] For example, in diabetes, glycosylated hemoglobin (HbA1c), foot ulcer, smoking status, and retinopathy are assessed on a regular basis which helps control the disease and also keeps the disease management costs in control.

Study results also showed that the mean expenses for total outpatient facility for a non-MSD were higher ($1,678.87) than the mean expenses for MSD's. This is consistent with previous studies that reported that the total outpatient facility charges were higher for non-MSD compared to MSD's.[44] Individuals suffering from MSD's require inpatient care and do not use outpatient care as much due to the nature of the disease condition.

Prescription drug utilization was higher in MSD's. Kaiser Foundation reported that around 10% of the total health care costs was due to prescription drugs alone.[50] It was suggested that the overall prescription costs has decreased, although there was an increase in the prescription costs in chronic conditions, especially in the aging population. Our study findings are consistent with those reported by Kaiser Foundation and demonstrates an increasing prescription drug utilization in MSD's.[46] Another reason for the increased prescription drugs costs in MSD's is the enormous costs of the new biological treatments that was introduced in the early 2000.

Study result indicated that office-based facility expenditures are lower for MSD's as compared to non-MSD. Office-based services include any infusion expenses and other

services administered to the patient in the physician's office. For example, biologics such as Remicade® is administered as an infusion in a physician's office. These expenditures are lower for MSD's due to the fact that MSD's require more inpatient care and mostly use prescription drugs to control their symptoms.

Studies have shown that chiropractic care is a cost-effective alternative to the management of musculoskeletal conditions.[51] Chiropractor care is required in the post-operative rehabilitation care and also in treatments which are non-invasive in nature such as OssaTron Orthotripsy method. Results indicated that there is a higher office-based chiropractor cost for non-MSD due to injuries resulting from slips, trips, falls, or similar accidents which are not included under MSD's. Similar to chiropractor expenditures, study results indicated that total emergency room facility for MSD's was lower ($257.49) compared to non-MSD. Those with MSD's seldom have disease flare ups which require them to go to emergency room. Most patients get relief from their relapses by taking their medications or by visiting the physician. Also, severe cases most likely use the inpatient facility than the emergency facility.

The national estimates for each service category were compared to previous estimates for the different service category expenditures. There has been a significant increase across the different service category costs. Inpatient service expenditures, prescription drug expenditures, and total health care expenditures have increased significantly over the last decade and a half.[24] On inflating these expenditures to the present day estimates (2011 value), the study confirms the significant incremental burden of MSD's on the health care system in the US compared to non-MSD.

Conclusions

There is a significant burden of the MSD's on the US health care system. The prevalence of MSD in the US was estimated at 11.3%. Approximately, 34,888,246 people were affected by at least one MSD condition in 2007. A majority of individuals affected by MSD's were whites and were in the southern region of the US. Given the high prevalence of MSD, the annual incremental direct medical expenditures for the treatment of MSD's was estimated at $30.25 billion (2007 value) and $35.61 billion (2011 value).

The annual incremental total health care expenditures associated with MSD's over non-MSD were $886.49 per person, an increase from $534.5 per person in the year 2006.[39] There was a significant cost burden of the MSD's on some health care services. This cost is still an underestimate of the true cost and could be higher if secondary diagnosis and indirect costs associated with MSD's are included in the analysis.

Study Implications

The present study improves upon some previous national estimates of MSD's and also estimated the major domains of healthcare utilization with predictors of these costs. The study findings are important for several reasons. The new healthcare reform bill with increased coverage for uninsured population coupled with an increase in aging population and increase in the prevalence of MSD's could potentially result in increased health care recourse utilization. Thus, there is a need to introduce strategies at the grass root level which will not only decrease the burden of MSD's on the health care system

but also reduce the overall costs associated with the disease. Strategies like disease screening and increased health literacy will be helpful in decreasing the overall disease prevalence by early detection and treatment. As discussed earlier, screening techniques such as the use of x-rays and ultrasound can be helpful in controlling the increase in disease severity in a timely manner. There have been increased cases of MSD's among individuals less than 18 years of age. There is a need to implement programs like health awareness among children about the causes of MSD's. For reducing resource utilization among elderly individuals suffering from chronic conditions, home health model could be implemented, that will help in decreasing the emergency room and inpatient facility expenses, and would also provide better care to the individuals.

This study will help the managed care organizations and payers such as Medicare in understanding the increased burden of MSD's. The systematic assessment of MSD's and their associated incremental costs to the society is essential in increasing the awareness of decision makers to implement intervention strategies that are effective in lowering the disease incidence and in reducing the overall cost of disease management. The implementation of disease management programs like home health and screening for early disease detection and the use of cost-effective treatments will help payers control the rising costs of MSDs, including the cost of MSD-related prescription drugs.

Study Limitations

The present study has some limitations: First, the limitations associated with a retrospective database are applicable to this study. Some of these limitations include

dependency on previously recorded data in the database, whose quality may be limited by systematic or recorder bias, data coding-recoding errors, incomplete data, data quality, and confounding factors. Second, we identified individuals with MSD's and non-MSD based on the self-reported medical conditions of the survey respondents. Based on the accuracy of the self-reported data, there is a possibility of f over-estimating or under-estimating disease prevalence. Third, the analysis only included direct medical expenses. Indirect cost such as loss of productivity transportation expenses, lost wages among family members, caregiver burden, etc., were not included in the estimation of the overall expenditures calculation. Fourth, the study included only patients with the primary diagnosis of MSD's, since MEPS does not provide secondary diagnosis. Finally, the low R-squared that is observed in the regression analyses should be considered. Non-experimental cross-sectional studies obtained from a panel or longitudinal data generally present a low R-squared in the estimation of the DV. The reason for the low R-squared may stem from the nature of the epidemiological data (longitudinal or panel) i.e., it is a combination of cross-sectional and time-series datasets, and the R-squared reported from an analysis using this type of data is rather "cross sectional-like". For instance, if one compares person A's outcomes with his/her own outcomes at different times (time-series) one can certainly explain much of the variation with just a few variables. However, if one compares person A's outcomes with person B's outcomes (cross-sectional) those same few variables will explain less, if any, of the variation. Thus, a cause for concern on a low R-squared depends on the type of dataset employed and the model.

CHAPTER SIX

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